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(54) IN-PLANE-SWITCHING MODE LIQUID CRYSTAL DISPLAY USING TWO NEGATIVE BIAXIAL RETARDATION FILMS AND A POSITIVE C-PLATE

IN DER EBENE SCHALTENDE (IPS) FLÜSSIGKRISTALLANZEIGE, WELCHE ZWEI NEGATIV-ZWEIACHSIGE VERZÖGERUNGSFILME UND EINE POSITIVE C-PLATTE VERWENDET

DISPOSITIF D'AFFICHAGE A CRISTAUX LIQUIDES A COMMUTATION DANS LE PLAN (IPS) UTILISANT DEUX COUCHES A RETARD BIAXIALES NÉGATIVES ET UNE LAME A RETARD DE TYPE C POSITIF

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Description

Technical Field

[0001] The present invention relates to an in-plane switching mode liquid crystal display (IPS-LCD) which employs two negative (-) biaxial retardation films and a +C-plate as optical compensation films. More particularly, the present invention relates to the use of two negative (-) biaxial retardation films and a +C-plate as optical compensation films for improving viewing angles of an IPS-LCD filled with liquid crystal molecules positive dielectric anisotropy ($\Delta\varepsilon>0$), thereby assuring high contrast properties and wide viewing angles at the surface-facing angle and tilt angles, and a small color shift in a black state.

[0002] This application claims the benefit of the filing date of Korean Patent Application Nos. 10-2005-0050856, filed on June 14, 2005, in the Korean Intellectual Property Office.

Background Art

[0003] . A TN (twisted nematic) mode LCD is a common type of conventional LCD using liquid crystal molecules that have positive dielectric anisotropy and are horizontally aligned in a twisted state between two facing substrates. However, the TN mode LCDs cannot display an absolute black state because of light leakage attributable to the birefringence due to the liquid crystal molecules near the substrates even when in an OFF-state. Meanwhile, there are LCDs to which various modes have recently been introduced so as to increase the width of viewing angles. Out of them, IPS-LCDs can display an almost complete black state in an OFF-state by way of the alignment of polarizers on the upper and lower surfaces of the substrates because the liquid crystal molecules are almost horizontally and uniformly aligned to the surfaces of the substrates in an OFF-state so that the light undergoes no change in the polarizer and thus can pass through the liquid crystal layer intact.

[0004] Without optical films, generally, wide viewing angles can be realized in these IPS-LCDs which thus assure high transmissivity and have uniform images and viewing angles over the screen. For these reasons, IPS-LCDs are prevalent in high quality displays having 18-inch or larger screens. In contrast, VA (vertically aligned) mode LCDs impart a display with a fast response speed, but have low transmissivity due to the presence of retardation films between liquid crystal cells and polarizers, required to solve the problems of phase difference and light leakage. Particularly, when subjected to external pressure, VA mode LCDs suffers from the disadvantage of low uniformity and stability due to liquid crystal dynamics.

[0005] Various examples of VA mode LCDs to which retardation films are applied to solve the problems of phase difference and light leakage are found in Japanese Pat. Laid-Open Publication Nos. 2003-262869, 2003-262870, and 2003-262871, in which a first and a second retardation plate, each consisting of at least one uni- or biaxial retardation film, is disposed between a first polarizer and a liquid crystal cell and between a second polarizer and the liquid crystal cell, respectively. The retardation film for use in compensating for viewing angles comprises an A-plate for compensating for in-plane retardation (R_{in}) and a C-plate for compensating for retardation in the thickness direction (R_{th}) that are placed properly so as to compensate viewing angles.

[0006] Examples of the IPS-LCDs which use optical retardation films to improve viewing angles are described in Korean Pat. Laid-Open Publication Nos. 2005-0031940, 2003-0079705 and 2005-0039587, the last invented by the present inventors, where a +A-plate and a +C-plate are arranged between the liquid crystal layer and the polarizer. Further examples of compensation schemes for IPS-LCD's based on the use of optical retardation films such as biaxial films are known from the following documents: Anderson J. E. et al., "Methods and concerns of compensating in-plane switching liquid crystal displays", Japanese Journal of Applied Physics, vol. 39, no. 11, pages 6388-6392; Saitoh Y. et al., "Optically Compensated In-Plane-Switching-Mode TFT-LCD Panel", 1998 SID International Symposium, pages 1-4; Saitoh Y. et al., "Optimum Film Compensation of Viewing Angle of Contrast in In-Plane-Switching-Mode Liquid Crystal Display", Japanese Journal of Applied Physics, vol. 37, no. 9A, pages 4822-4828; Ishinabe T. et al., "Wide- Viewing-Angle Polarizer with a Large Wavelength Range", Japanese Journal of Applied Physics, vol. 41, pages 4553-4558; JP 2001 242462 A.

[0007] In the art, much effort has continued to be made to widen viewing angles by way of, for example, novel and versatile lamination structures and configuring of retardation values.

Disclosure of Invention

Technical Problem

[0008] Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide an IPS-LCD filled with liquid crystal molecules having positive dielectric anisotropy, which has a novel laminated structure of retardation films so as to improve contrast properties at the surface-facing angle and tilt angles and minimize color change according to viewing angles in a black state, thereby providing a wider viewing angle than that of conventional LCDs.

Technical Solution

[0009] In accordance with an aspect of the present invention, provided is an in-plane switching mode liquid crystal display in accordance with the appended claim 1.

[0010] In accordance with the present invention, a backlight source is placed near the first polarizer or the second polarizer. Preferably, the first polarizer is placed near the backlight source of the LCDs. The first polarizer has an absorption axis parallel to the optical axis of the liquid crystal cell.

[0011] In an embodiment, when a wavelength of 550 nm is used, both the first and the second negative (-) biaxial retardation film range in in-plane retardation value from 20 nm to 100 nm while the +C-plate ranges in thickness retardation value from 50 nm to 500 nm.

[0012] Preferably, the second negative (-) biaxial retardation film is used as an inner protective film for the polarizer. The +C-plate may be made from a polymeric material or a UV-cured liquid crystal film.

Advantageous Effects

[0013] Having a contrast ratio of as high as 58.6:1 at the surface-facing angle and tilt angles, and undergoing a minimal color change with viewing angles in a black state, the IPS-LCD according to the present invention exhibits superior viewing angle compensation properties.

Brief Description of the Drawings

[0014] FIG. 1 is a cross sectional view showing the structure of a typical IPS-LCD.

[0015] FIG. 2 is a schematic view showing the arrangement relationship between an absorption axis of a polarizer and an optical axis of liquid crystal molecules in the IPS-LCD having the cross sectional structure of FIG. 1.

[0016] FIG. 3 is a view showing the definition of refractive indices of a retardation film.

[0017] FIG. 4 is a disassembled plan view showing the structure of an IPS-LCD according to a preferred embodiment of the present invention.

[0018] FIG. 5 is a view showing simulation results for the contrast ratio of the IPS-LCD according to Example 1-9 of the present invention at tilt angles from 0° to 80° with respect to entire radius angles when white light is used.

[0019] FIG. 6 is a view showing simulation results for the contrast ratio of the IPS-LCD according to Example 2-9 of the present invention at tilt angles from 0° to 80°with respect to entire radius angles when white light is used.

[0020] FIG. 7 is a view showing simulation results for the contrast ratio of the IPS-LCD according to Example 3-10 of the present invention at tilt angles from 0° to 80°with respect to entire radius angles when white light is used.

[0021] FIG. 8 is a view showing simulation results for the contrast ratio of the IPS-LCD according to Example 4-2 of the present invention at tilt angles from 0° to 80°with respect to entire radius angles when white light is used.

[0022] FIG. 9 is a view showing simulation results for the contrast ratio of the IPS-LCD according to Example 4-3 of the present invention at tilt angles from 0° to 80°with respect to entire radius angles when white light is used.

[0023] (1: first polarizer, 2: second polarizer, 3: in-plane switching (IPS) mode liquid crystal cell, 4: absorption axis of the first polarizer, 5: absorption axis of the second polarizer, 6: rubbing direction, 7: liquid crystal molecules, 8: refractive index in an x-axis direction, 9: refractive index in a y-axis direction, 10: refractive index in a z-axis direction, 11: first negative (-) biaxial retardation film, 12: +C-plate, 13: second negative (-) biaxial retardation film, 14, 15: optical axis)

Mode for the Invention

[0024] Below, a detailed description is given of the present invention with reference to the accompanying drawings.

[0025] In advance of presenting preferred embodiments of the present invention, a typical IPS-LCD is described to elucidate the basic structure, optical axis arrangement, and refractive index relationship of retardation films, with reference to FIGS. 1 to 3.

[0026] FIG. 1 is a cross sectional view showing the basic structure of an IPS-LCD in which an in-plane switching mode liquid crystal cell 3 is positioned between a first polarizer 1 and a second polarizer 2. The liquid crystal cell 3 is filled with liquid crystal molecules having positive dielectric anisotropy ($\Delta\varepsilon > 0$), which are horizontally aligned, between two glass substrates, as shown in the figure.

[0027] The absorption axes of the polarizers and the optical axis of the liquid crystal molecules in the IPS-LCDs are illustrated in FIG. 1 showing the cross sectional structure of the IPS-LCDs and FIG. 2 showing the arrangement of optical axes. As shown in the figures, the absorption axis 4 of the first polarizer 1 is arranged perpendicular to the absorption axis 5 of the second polarizer 2 and parallel to the optical axis 6 of a IPS mode liquid crystal cell 3. Typically, the first polarizer 1, the absorption axis of which is parallel to the optical axis of the IPS mode liquid crystal cell 3 of an in-plane switching mode, is preferred to be placed near a backlight source.

[0028] With reference to FIG. 3, a schematic view is provided for describing refractive indices relationship of retardation films used to compensate for viewing angles. When the refractive index in an x-axis direction is represented by n 8, the refractive index in x a y-axis direction is represented by n_y 9, and the refractive index in a z-axis direction is represented by n_z 10, the properties of the retardation film depend on the size of the refractive indices. When two among the three refractive indices of the respective axis directions differ from each other, the retardation film is called a uniaxial retardation film, which can be defined as follows:

[0029] When $n_x > n_y = n_z$, it is a +A-plate and an in-plane retardation value can be defined using the difference between the two in-plane refractive indices and the thickness of the film. That is, R_{in} (in-plane retardation value) = d x (n_x - n_y), wherein d represents a film thickness.

[0030] When $n_x = n_y < n_z$, it is a +C-plate and a thickness retardation value (R_{th}) can be defined using the difference between in-plane refractive index and the thickness refractive index, and the thickness of the film, as represented by R_{th} = d x (n_z - n_y), wherein d represents the film thickness. The +C-plate has an in-plane retardation value of almost zero and a positive thickness retardation value. The wavelength dispersion characteristics of the +C-plate film can be divided into normal wavelength dispersion, flat wavelength dispersion and reverse wavelength dispersion.

[0031] In contrast to the uniaxial retardation film, a biaxial retardation film has three refractive indices of respective axis directions which differ from one another. A biaxial retardation film can be defined as follows:

[0032] When $n_x > n_y > n_z$ wherein the refractive index in an x-axis direction is represented by n 8, the refractive index in a y-axis direction is represented by n 9, and the refractive index in a z-axis direction is represented by n 10, it is a negative (-) biaxial retardation film having both an in-plane retardation value (R_{in} = d x (n_x - n_y)) and a thickness retardation value (R_{th} = d x (n_z - n_y)), wherein d represents a film thickness.

[0033] In accordance with an embodiment of the present invention, the +C-plate and negative (-) biaxial retardation film defined as in the above can be properly arranged so as to improve viewing angles, as shown in the disassembled plan view of FIG. 4.

[0034] As seen in FIG. 4, an optical compensation film consisting of a first negative (-) biaxial retardation film 11 and a second negative (-) biaxial retardation film 13 with a +C-plate sandwiched therebetween is placed between an in-plane switching liquid crystal cell 3 and a second polarizer 2.

[0035] In the IPS mode liquid crystal cell 3 placed between the first polarizer 1 and the second polarizer 2 the respective absorption axes of which are perpendicular to each other, liquid crystal molecules 7 are arranged parallel to the substrates of the liquid crystal cell and aligned in the rubbing direction. In this structure, the first polarizer 1 may be positioned near the backlight source of the LCD. In this case, the LCD is called an O-mode IPS-LCD when the absorption axis 4 of the first polarizer 1 is parallel to the rubbing direction of the liquid crystal cell.

[0036] Polarization elements of the first polarizer 1 and the second polarizer 2 may be made from stretched PVA (polyvinyl alcohol). In order to protect the polarization elements of the first polarizer 1 and the second polarizer 2, a protective film may be provided on one side or both sides of the respective polarizers. Examples suitable for the protective film include a TAC (Triacetate Cellulose) film having a thickness retardation value, a PNB (Polynorbornene) film having a thickness retardation value, a COP film having no thickness retardation value, and a TAC having no thickness retardation value. A protective film having a thickness retardation value, such as a TAC film having a thickness retardation film, is disadvantageous in that it yields a poor viewing angle compensation effect. Instead, the use of an isotropic film, such as unstretched COP films or TAC films having low thickness retardation value (Low Re), assures an improvement in viewing angle compensation properties.

[0037] Inner protective films for the polarizers, which are placed to the side of the liquid crystal cells, are required to have superior transmissivity, mechanical strength, heat stability, moisture impermeability, and isotropy. As the inner protective films for the polarizers, films having no negative thickness retardation value or a negative thickness retardation value may be used. Examples of protective films useful in the present invention include films made from polyester-based polymers, such as polyethylene terephthalate and polyethylene phthalate; cellulose-based polymers, such as diacetyl cellulose and triacetyl cellulose; acryl-based polymers, such as polymethylmethacrylate, styrene-based polymers, such as polystyrene and acrylonitrile-styrene copolymer (AS resins); or polycarbonate-based polymers. Alternatively, the protective films may be made from a polymeric material selected from among polyolefinic-based polymers, vinyl chloride-based polymers, amide-based polymers such as nylon and aromatic polyamides, vinyl alcohol-based polymers, vinylidene chloride-based polymers, vinyl butyral-based polymers, allylate-based polymers, polyoxymethylene-based polymers, epoxy-based polymers, and combinations thereof. In addition, heat- or UV-curable resins based on acryl, urethane, acryl urethane, epoxy or silicon may be used.

[0038] Now, a description is given of the retardation films which act as the essential components of the present invention. A first negative (-) biaxial retardation film 11 and a second negative (-) biaxial retardation film 13 are placed adjacent to the IPS liquid crystal cell 3 and the second polarizer 2, respectively, while the +C-plate 12 is sandwiched between the first negative (-) biaxial retardation film 11 and the second negative (-) biaxial retardation film 13. Such arrangement is conducted in such a manner that the optical axis 14 of the first negative (-) biaxial retardation film 11 is perpendicular to that of the liquid crystal cell 3 while the optical axis 15 of the second negative (-) biaxial retardation film 13 is perpendicular to the absorption axis 5 of the second polarizer 2. When the absorption axis 4 of the first polarizer 1 is parallel to the optical axis 6 of the liquid crystal cell 3, the optical axis 14 of the first negative (-) biaxial retardation film 11 is arranged parallel to the absorption axis 5 of the second polarizer 2.

[0039] Films useful as the first and the second negative (-) biaxial retardation film 11, 13, are exemplified by a uniaxially stretched TAC film, a uniaxially stretched PNB (Polynorbornene) film, a biaxially stretched PC (Polycarbonate) film, a biaxially stretched COP film, and a biaxial liquid crystal (LC) film. In accordance with the present invention, the viewing angle in the diagonal direction can be greatly improved by employing two sheets of negative (-) biaxial retardation films.

[0040] The +C-plate 12 may be prepared from a polymer or UV-cured liquid crystal film. For example, a homeotropic aligned liquid crystal film, a biaxially stretched polycarbonate film, or a biaxially stretched COP film may be used.

[0041] The relationship between the retardation value of the first and the second negative (-) biaxial retardation film 11, 13, used to compensate the viewing angle of IPS-LCD, and the thickness retardation value of the +C-plate 12, meets the following formula $R_{th,+C} > |R_{th,biaxial}|$, that is, the thickness retardation value of the +C-plate 12 is larger than the absolute value of the sum of the thickness retardation values of the first and the second negative (-) biaxial retardation films 11, 13. Each of the first and the second negative (-) biaxial retardation films 11, 13 preferably ranges in in-plane retardation value from 20 nm to 100 nm when a wavelength of 550nm is used. As for the +C-plate 12, its thickness retardation value preferably ranges from 50 nm to 500 nm when a wavelength of 550 nm is used.

[0042] In accordance with the present invention, the second polarizer 2 is not provided with a separate inner protective film, but the second negative (-) biaxial retardation film 13 positioned on the second polarizer 2 may play a role as an inner protective film of the second polarizer.

[0043] In an embodiment, according to the present invention, the LCDs additionally comprise third negative (-) biaxial retardation film, a second +C-plate and a fourth negative (-) biaxial retardation film, as described in the above, between the liquid crystal cell 3 and the first polarizer 1. In this embodiment, the third negative (-) biaxial retardation film is arranged adjacent to the liquid crystal cell in such a manner so that its optical axis is perpendicular to the optical axis of the liquid crystal cell, the fourth negative (-) biaxial retardation film is arranged adjacent to the first polarizer in such a manner so that its optical axis is perpendicular to the absorption axis of the first polarizer, and the second +C-plate is arranged between the third negative (-) biaxial retardation film and the fourth negative (-) biaxial retardation film.

[0044] When a third negative (-) biaxial retardation film, a second +C-plate and a fourth negative (-) biaxial retardation film are positoned between the liquid crystal cell 3 and the first polarizer 1, the third negative (-) biaxial retardation film positioned on the first polarizer may play a role as an inner protective film of the first polarizer.

[0045] The retardation films in the structure were simulated with various parameters of in-plane retardation values and thickness retardation values, and the simulation results are summarized in Tables 1 to 4, below.

[0046] EXAMPLE 1

[0047] The IPS-LCD of Table 1 employed an IPS liquid crystal cell which had a cell gap of 3.4μm and a pretilt angle of 2°and was filled with liquid crystal molecules having a dielectric anisotropy of $\Delta\varepsilon$=+7 and a birefringence of Δn=0.1. For the first negative (-) biaxial retardation film 11, a biaxilly stretched COP film was used the in-plane retardation value and thickness retardation value of which are summarized in Table 1, below. A biaxially stretched COP film was used as the second negative (-) biaxial retardation film 13 and its in-plane retardation value and thickness retardation valueare given in Table 1, below. Acting as the +C-plate 12, a UV-cured, homeotropic aligned LC film with R_{th} = 310 nm was used. The first polarizer 1 included a COP inner protective film having a retardation value of almost zero and a 80μm thick TAC outer protective film. The second polarizer 2 included a 80μm-thick TAC outer protective film and the second negative (-) biaxial retardation film 13 played a role as an inner protective film of the second polarizer 2.

[0048]

Table 1

Ex. Nos.	Inner Protective Film of First polarizer	Retardation Values of IPS-Panel (nm)	B1-Plate		R_{th} of +C-Plate (nm)	B2-Plate		Minimum Contrast Ratio at Tilt Angle of 75°
			R_{in} (nm)	R_{th} (nm)		R_{in} (nm)	$R_{th(nm)}$	
1-1	Zero Re Film * (COP)	340	50	-105	310	30	-115	42.8
1-2						40		42.8
1-3						50		58.3
1-4						60		58.8
1-5						70		45.6
1-6						80		30.8
1-7	Zero Re Film(COP)	340	50	-115	310	30	-115	44.2
1-8						4		52.6
1-9						50		55.3
1-10						60		50.0
1-11						70		34.7
1-12						80		24.3
1-13	Zero Re Film(COP)	340	50	-125	310	30	-115	41.8
1-14						40		44.4
1-15						50		42.3
1-16						60		36.7
1-17						70		26.4
1-18						80		19.4
Zero Re Film : Film having retardation value of almost zero								

[0049] FIG. 5 shows simulation results for the contrast ratios of the LCD at tilt angles from 0° to 80° with respect to entire radius angles when white light was used in the following conditions (Example 1-9) out of the conditions of Table 1. As seen in FIG. 5, the minimum contrast ratio was measured to be 55.3:1 at an tile angle of 75° through the simulation.

[0050]

Inner Protective Film of First Polarizer	Retardation Values of IPS-Panel (nm)	B1-Plate		+C-Plate R_{th} (nm)	B2-Plate		Minimum Contrast Ratio at tilt angle of 75°
		R_{in} (nm)	R_{th} (nm)		R_{in} (nm)	R_{th} (nm)	
Zero Re Film (COP)	340	50	-115	310	50	-115	55.3

[0051] EXAMPLE 2

[0052] The IPS-LCD of Table 2 employed an IPS liquid crystal cell which had a cell gap of 3.4μm and a pretilt angle of 2° and was filled with liquid crystal molecules having a dielectric anisotropy of $\Delta\varepsilon$=+7 and a birefringence of Δn=0.1. For the first negative (-) biaxial retardation film 11, a biaxially stretched COP film was used, the in-plane retardation value and thickness retardation value of which are summarized in Table 2, below. A biaxially stretched COP film was used as the second negative (-) biaxial retardation film 13 and its in-plane retardation value and thickness retardation value are given in Table 2, below. Acting as the +C-plate 12, a UV-cured, homeotropic aligned LC film with R_{th} = 320nm was used. The first polarizer 1 included a COP inner protective film having a retardation value of almost Zero and a

80μm thick TAC outer protective film. The second polarizer 2 included a 80μm-thick TAC outer protective film and the second negative (-) biaxial retardation film 13 played a role as an inner protective film of the second polarizer 2.

[0053]

Table 2

Ex. Nos.	Inner Protective Film of First polarizer	Retardation Values of IPS-Panel (nm)	B1-Plate		R_{th} of +C-Plate (nm)	B2-Plate		Minimum Contrast Ratio at Tilt Angle of 75°
			R_{in} (nm)	R_{th} (nm)		R_{in} (nm)	R_{th} (nm)	
2-1	Zero Re Film*(COP)	340	50	-105	320	30	-115	35.4
2-2						40		51.2
2-3						50		58.3
2-4						60		59.1
2-5						70		59.1
2-6						80		48.9
2-7	Zero Re Film(COP)	340	50	-115	320	30	-115	41.4
2-8						40		55.8
2-9						50		58.6
2-10						60		59.1
2-11						70		57.8
2-12						80		38.7
2-13	Zero Re Film(COP)	340	50	-125	320	30	-115	46.3
2-14						40		57.0
2-15						50		58.6
2-16						60		59.1
2-17						70		45.5
2-18						80		30.4

[0054] FIG. 6 shows simulation results for the contrast ratios of the LCD at tilt angles from 0° to 80° with respect to entire radius angles when white light was used in the following conditions (Example 2-9) out of the conditions of Table 2. As seen in FIG. 6, the minimum contrast ratio was measured to be 58.6:1 at an tilt angle of 75° through the simulation.

[0055]

Inner Protective Film of First Polarizer	Retardat ion Values of IPS-Pan el (nm)	B1-Plate		+C-Plate R_{th} (nm)	B2-Plate		Minimun Contrast Ratio at tilt angle of 75*
		R_{in} (nm)	Rt_h (nm)		R_{in} (nm)	R_{th} (nm)	
Zero Re	340 Film (COP)	50	-115	320	50	-115	58.6

[0056] EXAMPLE 3

[0057] The IPS-LCD of Table 3 employed an IPS liquid crystal cell which had a cell gap of 3.4μm and a pretilt angle of 2° and was filled with liquid crystal molecules having a dielectric anisotropy of $\Delta\varepsilon$=+7 and a birefringence of Δn=0.1. For the first negative (-) biaxial retardation film 11, a biaxially stretched COP film was used, the in-plane retardation value and thickness retardation value of which are summarized in Table 3, below. A biaxially stretched COP film was used as the second negative (-) biaxial retardation film 13 and its in-plane retardation value and thickness retardation value are given in Table 3. Acting as the +C-plate 12, a UV-cured, homeotropic aligned LC film with R =330 nm was used. The first polarizer 1 included a COP inner protective film having a retardation value of almost zero and a 80μm thick TAC outer protective film. The second polarizer 2 included a 80μm thick TAC outer protective film and the second negative (-) biaxial retardation film 13 played a role as an inner protective film of the second polarizer 2.

[0058]

Table 3

EEx. Nos.	Inner Protective Film of First polarizer	Retardation Values of IPS-Panel (nm)	B1-Plate		+C-Plate (R_{th} nm)	B2-Plate		Minimum Contrast Ratio at tilt angle of 75°
			R_{in} (nm)	R_{th} (nm)		R_{in}(nm)	$R_{th(nm)}$	
3-1	Zero Re Film(COP)	340	50	-105	330	30	-115	31.0
3-2						40		45.8
3-3						50		58.3
3-4						60		59.1
3-5						70		59.4
3-6						80		57.3
3-7	Zero Re Film(COP)	340	50	-115	330	30	-115	37.5
3-8						40		53.7
3-9						50		58.6
3-10						60		59.4
3-11						70		59.4
3-12						80		46.9
3-13	Zero Re Film(COP)	340	50	-125	330	30	-115	43.9
3-14						40		57.0
3-15						50		58.8
3-16						60		59.4
3-17						70		58.3
3-18						80		37.2

[0059] FIG. 7 shows simulation results for the contrast ratios of the LCD at tilt angles from 0° to 80° with respect to entire radius angles when white light was used in the following conditions (Example 3-10) out of the conditions of Table 3. As seen in FIG. 7, the minimum contrast ratio was measured to be 59.4:1 at an angle of 75° through the simulation.

[0060]

Retardation Values of IPS-Panel (nm)	Retardation Values of IPS-Panel (nm)	B1-Plate		+C-Plate R_{th} (nm)	B2-Plate		Minimum Contrast Ratio at tilt angle of 75°
		R_{in} (nm)	R_{th} (nm)		R_{in} (nm)	R_{th} (nm)	
Zero Re Film (COP)	340	50	-115	330	60	-115	59.4

[0061] EXAMPLE 4

[0062] The IPS-LCD of Table 4 employed an IPS liquid crystal cell which had a cell gap of 3.4μm and a pretilt angle of 2° and was filled with liquid crystal molecules having a dielectric anisotropy of $\Delta\varepsilon$=+7 and a birefringence of Δn=0.1. For the first negative (-) biaxial retardation film 11, a biaxially stretched COP film having the in-plane retardation value

R_{in} =50 nm and the thickness retardation value R_{th} = -115 nm was used. A biaxially stretched COP film having the in-plane retardation value R_{in} = 50nm and the thickness retardation value R_{in} =-115 nm was used as the second negative (-) biaxial retardation film 13. Acting as the +C-plate 12, a UV-cured, homeotropic aligned LC film with R_{th} =330 nm was used. The first polarizer 1 included a 50μm -thick TAC film having R_{th} =-30nm or a 80μm-thick TAC film having R=-50nm as an inner protective film, and a 80μm-thick TAC outer protective film. The second polarizer 2 included a 80μm-thick TAC outer protective film and the second negative (-) biaxial retardation film 13 played a role as an inner protective film of the second polarizer 2.

[0063]

Table 4

Ex. Nos.	Inner Protective Film of First polarizer	Retardation Values of IPS-Panel (nm)	B1-Plate		R_{th} of +C-Plate (nm)	B2-Plate		Minimum Contrast Ratio at Tilt Angle of 75°
			R_{in} (nm)	$R_{th(nm)}$		R_{in}(nm)	$R_{th\ nm}$	
4-1	Zero Re Film (COP)	340	50	-115	330	50	-115	58.6
4-2	500 TAC(-30nm)	340	50	-115	330	50	-115	24.4
4-3	800 TAC(-50nm)	340	50	-115	330	50	-115	11

[0064] FIG. 8 shows simulation results for the contrast ratios of the LCD at tilt angles from 0° to 80° with respect to entire radius angles when white light was used in the following conditions (Example 4-2) out of the conditions of Table 4. As seen in FIG. 8, the minimum contrast ratio was measured to be 24.4:1 at an tilt angle of 75° through the simulation.

[0065]

Inner Protective Film of First Polarizer	Retardation Values of IPS-Panel (nm)	B1-Plate		R_{th} of +C-Plate (nm)	B2-Plate		Minimum Contrast Ratio at tilt angle of 75°
		R_{in} (nm)	R_{th} (nm)		R_{in} (nm)	R_{th} (nm)	
50μm TAC (-30nm)	340	50	-115	330	50	-115	24.4

[0066] FIG. 9 shows simulation results for the contrast ratios of the LCD at tilt angles from 0° to 80° with respect to entire radius angles when white light was used in the same conditions (Examples 4-3) as in FIG. 8, except for the thickness retardation value(R_{th}) of the inner protective film of the first polarizer 1. As seen in FIG. 9, the minimum contrast ratio was measured to be 11:1 at an tilt angle of 75° through the simulation.

[0067]

Inner Protective Film of First Polarizer	Retardation Values of IPS-Panel (nm)	B1-Plate		R_{th} of +C-Plate (nm)	B2-Plate		Minimum Contrast Ratio at tilt angle of 75°
		R_{in} (nm)	R_{th} (nm)		R_{in} (nm)	R_{th} (nm)	
80μm TAC (-50nm)	340	50	-115	330	50	-115	11

[0068] Comparative Example 1

[0069] The IPS-LCD of Table 5 employed an IPS liquid crystal cell which had a cell gap of 3.4μm and a pretilt angle of 2° and was filled with liquid crystal molecules having a dielectric anisotropy of $\Delta\varepsilon$=+7 and a birefringence of Δn=0.1. A biaxially stretched COP film was used as the second negative (-) biaxial retardation film 13 and its in-plane retardation value and thickness retardation value are given in Table 5. Acting as the +C-plate 12, a UV-cured, homeotropic aligned LC- film with R_{th} =120 nm was used. The first negative (-) biaxial retardation film 11 was not used. The first polarizer 1 included 80μm-thick TAC films having R_{th}=-50nm as an inner protective film and an outer protective film, and the second negative (-) biaxial retardation film 13 played a role as an inner protective film of the second polarizer 2.

[0070] The minimum contrast ratio was measured to be 30:1 at an tilt angle of 75°. This value is very low when compared with the minimum contrast ratio (58.6:1) of the LCD of Example 4-1 at an tilt angle of 75°.

[0071]

Table 5

CR properties in the LCD using one negative (-) biaxial film and one +C-plate								
Ex./C.Ex. Nos.	Inner Protective Film of First polarizer	Retardation Values in of IPS- Panel (nm)	B1-Plate		R_{th} of +C-Plate (nm)	B2-Plate		Minimum Contrast Ratio at Tilt Angle of 75°
			R_{in}) (nm	$R_{th\ nm}$		$R_{in\ (nm)}$	R_{th} (nm)	
C.Ex.1	80μm TAC(-50nm)	340	B1-plate not available		120	66	-128	30
Ex.4-1	Zero Re Film (COP)	340	50	-115	330	50	-115	58.6

Claims

1. An in-plane switching mode liquid crystal display comprising:

   a liquid crystal cell (3) comprising two substrates and uniaxial liquid crystal molecules (7) having positive dielectric anisotropy and aligned between the two substrates so as to be parallel to the two substrates in the absence of an applied electric field ; and
   first and second polarizers (1, 2) having perpendicular absorption axes (4,5), the liquid crystal cell (3) being located between the first and second polarizers (1, 2);
   wherein:

   the following components a) - c) are located between the liquid crystal cell (3) and the second polarizer (2):

   a) a first negative biaxial retardation film (11) arranged adjacent to the liquid crystal cell (3) so that an optical axis (14) of the film is perpendicular to the optical axis (6) of the liquid crystal cell (3);
   b) a second negative biaxial retardation film (13) arranged adjacent to the second polarizer (2) so that an optical axis (15) of the film is perpendicular to the absorption axis (5) of the second polarizer (2); and
   c) a first positive C-plate (12) between the first negative biaxial retardation film (11) and the second negative biaxial retardation film (13);

   the absorption axis (4) of the first polarizer (1) is parallel to the optical axis (6) of the liquid crystal cell (3); and the first positive C-plate (12) has a thickness retardation positive value larger than the absolute value of the sum of the thickness retardation values of the first negative biaxial retardation film (11) and the second negative biaxial retardation film (13).

2. An in-plane switching mode liquid crystal display according to Claim 1, wherein the first negative biaxial retardation film (11) has an in-plane retardation value of 20 nm to 100 nm at a wavelength of 550 nm.

3. An in-plane switching mode liquid crystal display according to Claim 1, wherein the second negative biaxial retardation film (13) has an in-plane retardation value of 20 nm to 100 nm at a wavelength of 550 nm.

4. An in-plane switching mode liquid crystal display according to Claim 1, wherein the first positive C-plate (12) has a thickness retardation value of 50 nm to 500 nm at a wave-ength of 550 nm.

5. An in-plane switching mode liquid crystal display according to Claim 1, wherein the first and second negative biaxial retardation films (11 and 13) are each selected from a uniaxially-stretched triacetate cellulose film, a uniaxially-

stretched polynorbornene film, a biaxially-stretched polycarbonate film, a biaxially-stretched cycloolefin polymer film, a UV-curable biaxial liquid crystal film and combinations thereof.

6. An in-plane switching mode liquid crystal display according to Claim 1, wherein the first positive C-plate (12) is a positive homeotropic aligned UV-curable liquid crystal film, a polymer film or a combination thereof.

7. An in-plane switching mode liquid crystal display according to Claim 1, further comprising a protective film on one side or both sides of the first polarizer (1) and/or the second polarizer (2).

8. An in-plane switching mode liquid crystal display according to Claim 7, wherein the protective film is selected from a triacetate cellulose film having a thickness retardation, a polynorbornene film having a thickness retardation, a cycloolefin polymer film having no thickness retardation and a triacetate cellulose film having no thickness retardation.

9. An in-plane switching mode liquid crystal display according to Claim 1, further comprising an inner protective film on the side of the first polarizer (1) facing the liquid crystal cell (3) and/or on the side of the second polarizer (2) facing the liquid crystal cell (3), the inner protective film having no thickness retardation or a negative thickness retardation value.

10. An in-plane switching mode liquid crystal display according to Claim 9, wherein the inner protective film is formed from a polymeric material selected from polyester-based polymers, cellulose-based polymers, acrylic-based polymers, styrenic-based polymers, polycarbonate-based polymers, polyolefinic polymers, vinyl chloride-based polymers, amide-based polymers, vinyl alcohol-based polymers, vinylidene chloride-based polymers, vinylbutyral-based polymers, allylate-based polymers, polyoxymethylene-based polymers, epoxy-based polymers, urethanic-based resins, acryl urethanic-based resins, epoxy-based resins, silicon-based resins and combinations thereof.

11. An in-plane switching mode liquid crystal display according to Claim 1, wherein the second negative biaxial retardation film (13) is positioned on the second polarizer (2) so as to constitute an inner protective film for the second polarizer (2).

12. An in-plane switching mode liquid crystal display according to Claim 1, further comprising a backlight source near a side of the first.polarizer (1) or a side of the second polarizer (2).

13. An in-plane switching mode liquid crystal display according to Claim 12, wherein the backlight source is near a side of the first polarizer (1).

14. An in-plane switching mode liquid crystal display according to Claim 1, further comprising the following components d)- f) between the liquid crystal cell (3) and the first polarizer (1) :

d) a third negative biaxial retardation film arranged adjacent to the liquid crystal cell (3) so that an optical axis of the film is perpendicular to the optical axis (6) of the liquid crystal cell (3);
e) a fourth negative biaxial retardation film arranged adjacent to the first polarizer (1) so that an optical axis of the film is perpendicular to the absorption axis (4) of the first polarizer (1); and
f) a second positive C-Plate between the third negative biaxial retardation film and the fourth negative biaxial retardation film.

15. An in-plane switching mode liquid crystal display according to Claim 14, wherein the fourth negative biaxial retardation film is positioned on the first polarizer (1) so as to constitute an inner protective film for the first polarizer (1).

Patentansprüche

1. Flüssigkristallanzeige vom In-Plane-Switching-Modus, umfassend:

eine Flüssigkristallzelle (3), umfassend zwei Substrate und uniaxiale Flüssigkristallmoleküle (7), die positive dielektrische Anisotropie aufweisen und die zwischen den zwei Substraten so ausgerichtet sind, dass sie in der Abwesenheit eines angelegten elektrischen Feldes zu den zwei Substraten parallel sind; und
erste und zweite Polarisatoren (1, 2), die rechtwinklige Absorptionsachsen (4, 5) aufweisen, wobei die Flüssigkristallzelle (3) zwischen den ersten und zweiten Polarisatoren (1, 2) lokalisiert ist;
worin:

die folgenden Komponenten a) bis c) zwischen der Flüssigkristallzelle (3) und dem zweiten Polarisator (2) lokalisiert sind:

a) ein erster, negativer, biaxialer Retardationsfilm/bzw. eine -folie (11), angeordnet angrenzend zu der Flüssigkristallzelle (3), so dass die optische Achse (14) des Films/der Folie rechtwinklig zur optischen Achse (6) der Flüssigkristallzelle (3) steht;
b) ein zweiter, negativer, biaxialer Retardationsfilm/bzw. eine -folie (13), angeordnet angrenzend an den zweiten Polarisator (2), so dass eine optische Achse (15) des Films/bzw. der Folie rechtwinklig zu der Absorptionsachse (5) des zweiten Polarisators (2) steht; und
c) eine erste, positive C-Platte (12) zwischen dem ersten, negativen, biaxialen Retardationsfilm/bzw. der -folie (11) und dem zweiten, negativen, biaxialen Retardationsfilm/bzw. der -folie (13);

wobei die Absorptionsachse (4) des ersten Polarisators (1) parallel zur optischen Achse (6) der Flüssigkristallzelle (3) steht; und
die erste, positive C-Platte (12) einen Dicken-Retardationswert aufweist, der größer ist als der Absolutwert der Summe der Dicken-Retardationswerte von dem ersten, negativen, biaxialen Retardationsfilm/bzw. der -folie (11) und dem zweiten, negativen, biaxialen Retardationsfilm/bzw. der -folie (13).

2. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 1, worin der erste, negative, biaxiale Retardationsfilm/bzw. die -folie (11) einen In-Plane-Retardationswert von 20 nm bis 100 nm bei einer Wellenlänge von 550 nm aufweist.

3. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 1, worin der zweite, negative, biaxiale Retardationsfilm/bzw. die -folie (13) einen In-Plane-Retardationswert von 20 nm bis 100 nm bei einer Wellenlänge von 550 nm aufweist.

4. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 1, worin die erste, positive C-Platte (12) einen positiven Dicken-Retardationswert von 50 nm bis 500 nm bei einer Wellenlänge von 550 nm aufweist.

5. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 1, worin der erste und der zweite, negative, biaxiale Retardationsfilm/bzw. die -folien (11 und 13) jeweils ausgewählt sind aus einem uniaxial gestreckten Triacetatcellulosefilm/-folie, einem uniaxial gestreckten Polynorbornenfilm/-folie, einem biaxial gestreckten Polycarbonatfilm/-folie, einem biaxial gestreckten Cycloolefinpolymerfilm/-folie, einem UV-härtbaren, biaxialen Flüssigkristallfilm (bzw. -folie) und Kombinationen hiervon.

6. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 1, worin die erste positive C-Platte (12) ein homeotrop ausgerichteter UV-härtbarer Flüssigkristallfilm bzw. -folie, ein Polymerfilm, ein Polymerfilm bzw. -folie oder eine Kombination hiervon ist.

7. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 1, ferner umfassend einen Schutzfilm bzw. -folie auf einer Seite oder beiden Seiten des ersten Polarisators (1) und/oder des zweiten Polarisators (2).

8. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 7, worin der Schutzfilm bzw. -folie ausgewählt ist aus einem Triacetatcellulosefilm/-folie mit einer Dicken-Retardation, einem Polynorbornenfilm bzw. -folie mit einer Dicken-Retardation, einem Cycloolefinfilm bzw. -folie ohne Dicken-Retardation und einem Triacetatcellulosefilm bzw. -folie ohne Dicken-Retardation.

9. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 1, ferner umfassend einen inneren Schutzfilm bzw. -folie auf der Seite des ersten Polarisators (1), die zu der Flüssigkristallzelle (3) zeigt, und/oder auf der Seite des zweiten Polarisators (2), die zu der Flüssigkristallzelle (2) zeigt, wobei der innere Schutzfilm bzw. -folie keine Dicken-Retardation oder einen negativen Dicken-Retardationswert aufweist.

10. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 9, worin der innere Schutzfilm bzw. -folie gebildet ist aus einem polymeren Material, ausgewählt aus Polyester-basierten Polymeren, Cellulosebasierten Polymeren, Acryl-basierten Polymeren, Styrolbasierten Polymeren, Polycarbonat-basierten Polymeren, polyolefinischen Polymeren, Vinylchlorid-basierenden Polymeren, Amid-basierten Polymeren, Vinylalkoholbasierten Polymeren, Vinylidenchlorid-basierten Polymeren, Vinylbutyral-basierten Polymeren, Allylatbasierten Polymeren, Polyoxymethylen-basierten Polymeren, Epoxy-basierten Polymeren, Urethan-basierten Harzen, Acryl-Urethan-basierten

Harzen, Epoxy-basierten Harzen, Silicium-basierten Harzen und Kombinationen hiervon.

11. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 1, worin der zweite, negative, biaxiale Retardationsfilm(bzw. eine -folie (13) einen inneren Schutzfilm/bzw. eine -folie für den zweiten Polarisator (2) aufweist.

12. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 1, ferner umfassend eine Rücklichtquelle nahe einer Seite des ersten Polarisators (1) oder einer Seite des zweiten Polarisators (2).

13. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 12, worin die Rücklichtquelle nahe einer Seite des ersten Polarisators (1) ist.

14. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 1, ferner umfassend die folgenden Komponenten d) bis f) zwischen der Flüssigkristallzelle (3) und dem ersten Polarisator (1):

d) einen dritten, negativen, biaxialen Retardationsfilm bzw. -folie, angeordnet angrenzend zu der Flüssigkristallzelle (3), so dass eine optische Achse des Films bzw. der Folie rechtwinklig zu der optischen Achse (6) der Flüssigkristallzelle (3) steht;
e) einen vierten, negativen, biaxialen Retardationsfilm bzw. -folie, angeordnet angrenzend zu dem ersten Polarisator (1), so dass eine optische Achse des Films bzw. der Folie rechtwinklig zu der Absorptionsachse (4) des ersten Polarisators (1) steht; und
f) eine zweite, positive C-Platte zwischen dem dritten, negativen, biaxialen Retardationsfilm bzw. der -folie und dem vierten, negativen, biaxialen Retardationsfilm bzw. der -folie.

15. Flüssigkristallanzeige vom In-Plane-Switching-Modus gemäß Anspruch 14, worin der vierte, negative, biaxiale Retardationsfilm bzw. die -folie auf dem ersten Polarisator (1) so positioniert ist, um einen Schutzfilm bzw. -folie für den ersten Polarisator (1) zu bilden.

Revendications

1. Dispositif d’affichage à cristaux liquides en mode de commutation dans le plan comprenant :

une cellule de cristaux liquides (3) comprenant deux substrats et des molécules de cristaux liquides (7) uniaxials ayant une anisotropie diélectrique positive et alignées entre les deux substrats de manière à être parallèles aux deux substrats (1, 2) en l’absence d’un champ électrique appliqué ; et
un premier et un deuxième polariseurs (1, 2) ayant des axes d’absorption (4, 5) perpendiculaires, la cellule de cristaux liquides (3) étant située entre le premier et le deuxième polariseurs (1, 2) ;
dans lequel :

les composants a) - c) suivants sont situés entre la cellule de cristaux liquides (3) et le deuxième polariseur (2) :

a) un premier film à retard biaxial négatif (11) agencé de façon adjacente à la cellule de cristaux liquides (3) de telle manière qu’un axe optique (14) du film est perpendiculaire à l’axe optique (6) de la cellule de cristaux liquides (3) ;
b) un deuxième film à retard biaxial négatif (13) agencé de façon adjacente au deuxième polariseur (2) de telle manière qu’un axe optique (15) du film est perpendiculaire à l’axe d’absorption (5) du deuxième polariseur (2) ; et
c) une première lame C positive (12) entre le premier film à retard biaxial négatif (11) et le deuxième film à retard biaxial négatif (13) ;

l’axe d’absorption (4) du premier polariseur (1) est parallèle à l’axe optique (6) de la cellule de cristaux liquides (3) ; et
la première lame C positive (12) a une valeur de retard dû à l’épaisseur plus grande que la valeur absolue de la somme des valeurs de retard dû à l’épaisseur du premier film à retard biaxial négatif (11) et du deuxième film à retard biaxial négatif (13).

2. Dispositif d’affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 1, dans lequel le premier film à retard biaxial négatif (11) a une valeur de retard dans le plan de 20 nm à 100 nm à une longueur d'onde de 550 nm.

3. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 1, dans lequel le deuxième film à retard biaxial négatif (13) a une valeur de retard dans le plan de 20 nm à 100 nm à une longueur d'onde de 550 nm.

4. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 1, dans lequel la première lame C positive (12) a une valeur de retard dû à l'épaisseur de 50 nm à 500 nm à une longueur d'onde de 550 nm.

5. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 1, dans lequel le premier et le deuxième films à retard biaxiaux négatifs (11 et 13) sont chacun choisis parmi un film de triacétate de cellulose à étirement uniaxial, un film de polynorbornéne à étirement uniaxial, un film de polycarbonate a étirement biaxial, un film de polymère de cyclooléfine a étirement biaxial, un film de cristaux liquides biaxial durcissable aux UV et une combinaison de ceux-ci.

6. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 1, dans lequel la première lame C positive (12) est un film de cristaux liquides durcissable aux UV aligné de façon homéotrope, un film polymère, ou une combinaison de ceux-ci.

7. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 1, comprenant en outre un film de protection sur un côté ou les deux côtés du premier polariseur (1) et/ou du deuxième polariseur (2).

8. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 7, dans lequel le film de protection est choisi parmi un film de triacétate de cellulose ayant un retard dû à l'épaisseur, un film de polynorbornène ayant un retard dû à l'épaisseur, un film de polymère de cyclooléfine n'ayant pas de retard dû à l'épaisseur et un film de triacétate de cellulose n'ayant pas de retard dû à l'épaisseur.

9. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 1, comprenant en outre un film de protection intérieur sur le côté du premier polariseur (1) faisant face à la cellule de cristaux liquides (3) et/ou sur le côté du deuxième polariseur (2) faisant face à la cellule de cristaux liquides (3), le film de protection intérieur n'ayant pas de retard dû à l'épaisseur ou ayant une valeur négative de retard dû à l'épaisseur.

10. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 9, dans lequel le film de protection intérieur est formé à partir d'un matériau polymérique choisi parmi des polymères à base de polyester, des polymères à base de cellulose, des polymères à base d'acrylique, des polymères à base de styrène, des polymères à base de polycarbonate, des polymères polyoléfiniques, des polymères à base de chlorure de vinyl, des polymères à base d'amide, des polymères à base d'alcool vinylique, des polymères à base de chlorure de vinylidène, des polymères à base de vinyl butyral, des polymères à base d'allylate, des polymères à base de polyoxyméthylène, des polymères à base d'époxy, des résines à base d'uréthane, des résines à base d'uréthane acrylique, des résines à base d'époxy, des résines à base de silicium et des combinaisons de ceux-ci.

11. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 1, dans lequel le deuxième film à retard biaxial négatif (13) est positionné sur le deuxième polariseur (2) de manière à constituer un film de protection intérieur pour le deuxième polariseur (2).

12. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 1, comprenant en outre une source de rétroéclairage à proximité d'un côté du premier polariseur (1) ou d'un côté du deuxième polariseur (2).

13. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 12, dans lequel la source de rétroéclairage est à proximité d'un côté du premier polariseur (1).

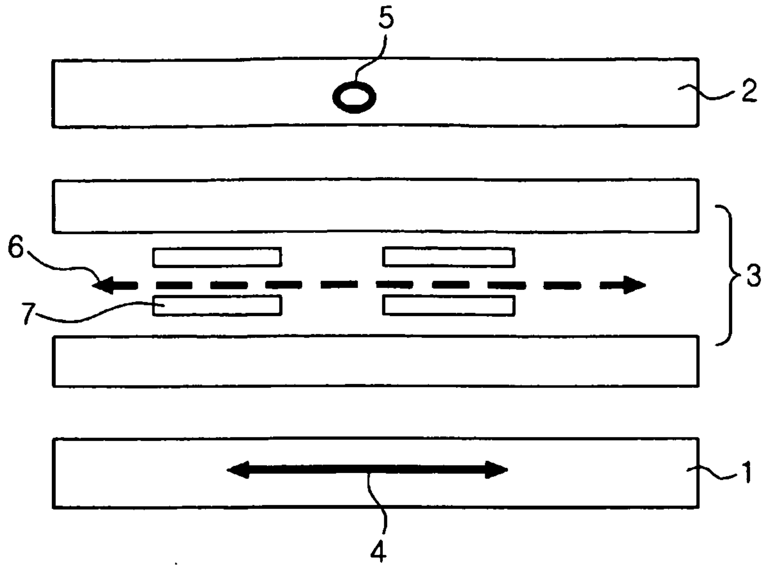
14. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 1, comprenant en outre les composants d) - f) suivants entre la cellule de cristaux liquides (3) et le premier polariseur (1) :

d) un troisième film à retard biaxial négatif agencé de façon adjacente à la cellule de cristaux liquides (3) de

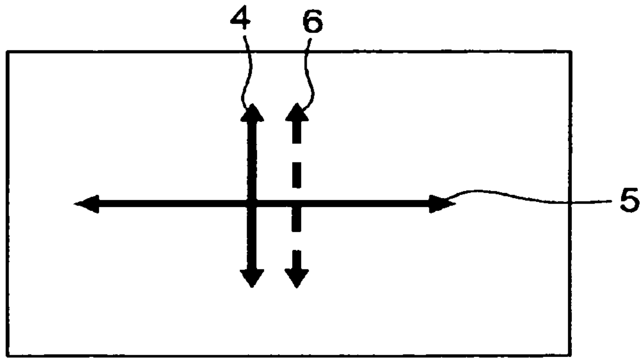
telle manière qu'un axe optique du film est perpendiculaire à l'axe optique (6) de la cellule de cristaux liquides (3) ;
e) un quatrième film à retard biaxial négatif agencé de façon adjacente au premier polariseur (1) de telle manière qu'un axe optique du film est perpendiculaire à l'axe d'absorption (4) du premier polariseur (1) ; et
f) une deuxième lame C positive entre le troisième film à retard biaxial négatif et le quatrième film à retard biaxial négatif.

15. Dispositif d'affichage à cristaux liquide en mode de commutation dans le plan selon la revendication 14, dans lequel le quatrième film à retard biaxial négatif est positionné sur le premier polariseur (1) de manière à constituer un film de protection intérieur pour le premier polariseur (1).

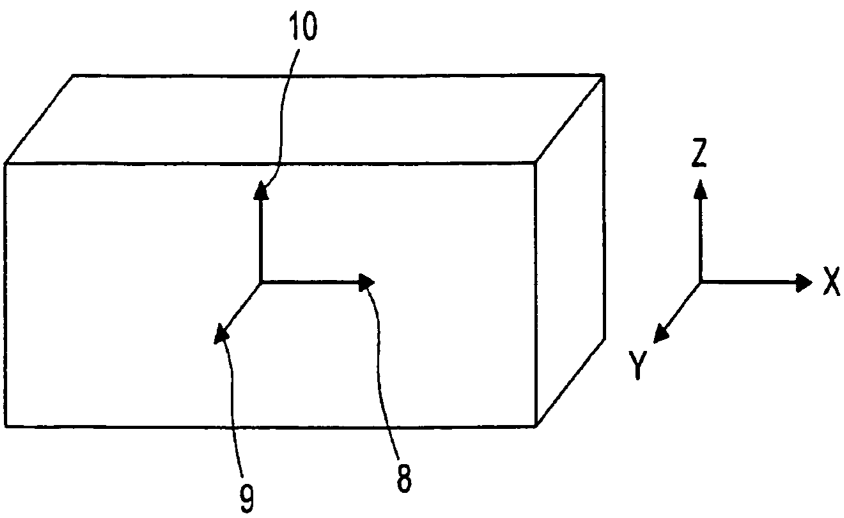
[Fig. 1]



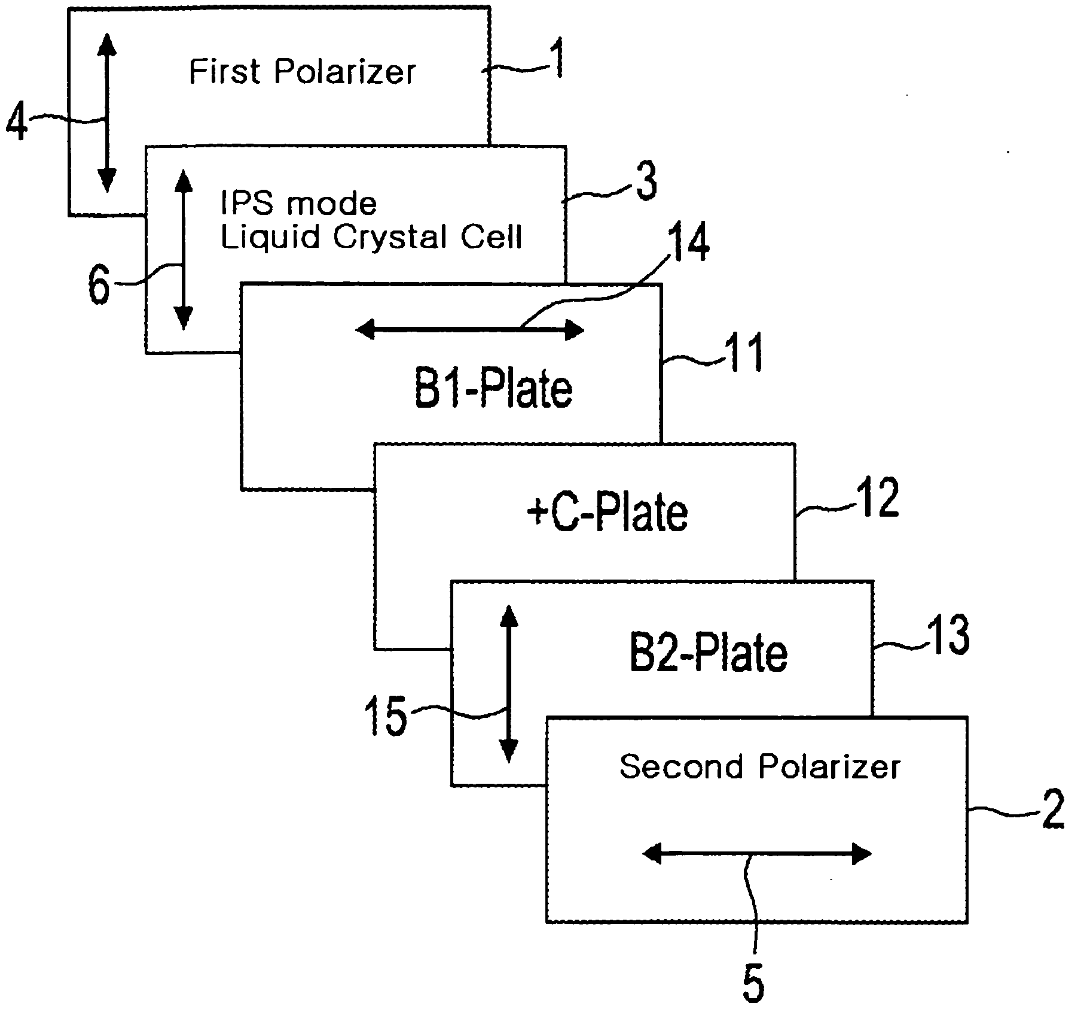
[Fig. 2]



[Fig. 3]

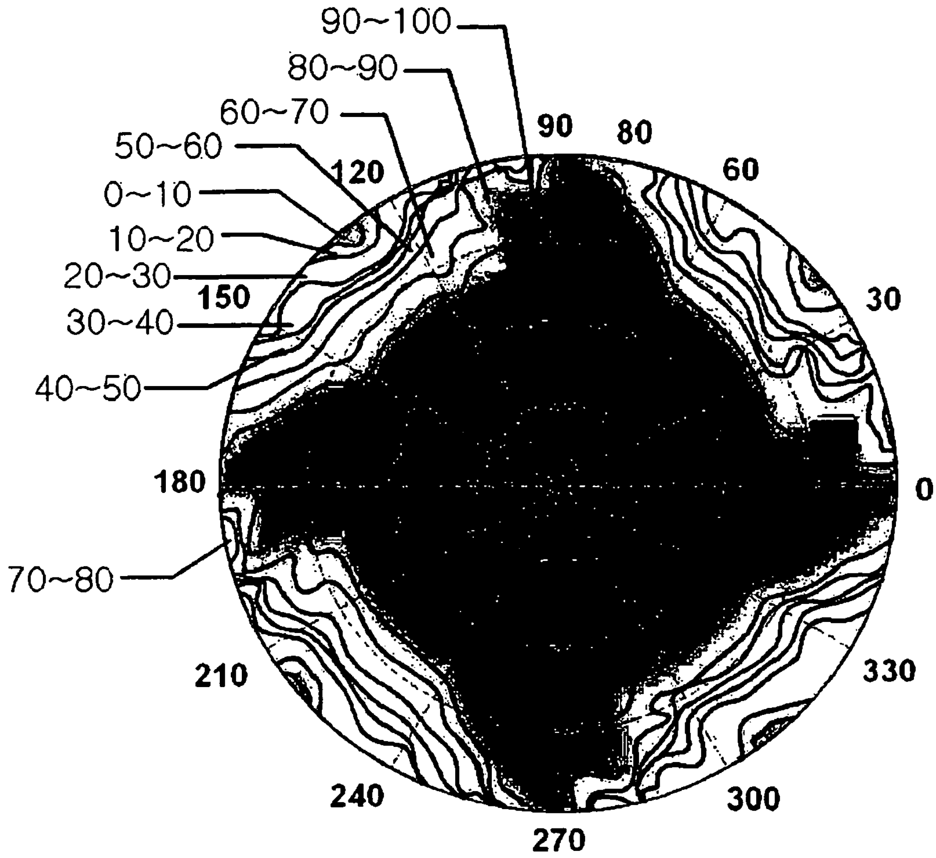


[Fig. 4]



First Polarizer
1
4
IPS mode
Liquid Crystal Cell
3
6
14
B1-Plate
11
+C-Plate
12
B2-Plate
13
15
Second Polarizer
2
5

[Fig. 5]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60~70
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10~20
20~30
30~40
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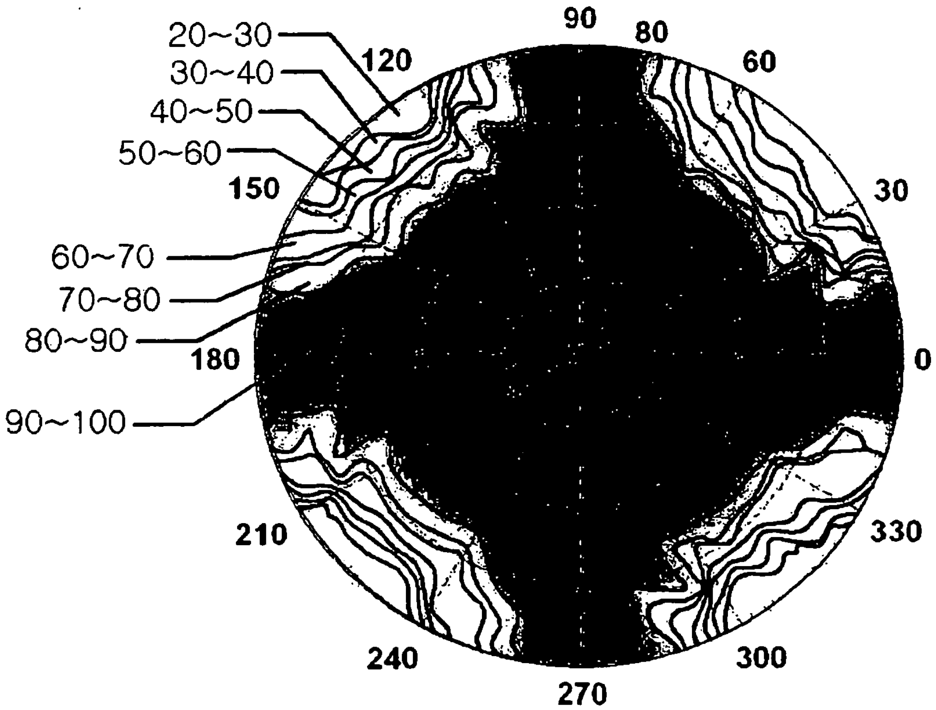
90
80
60
120
150
30
180
0
210
330
240
300
270

[Fig. 6]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150
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210
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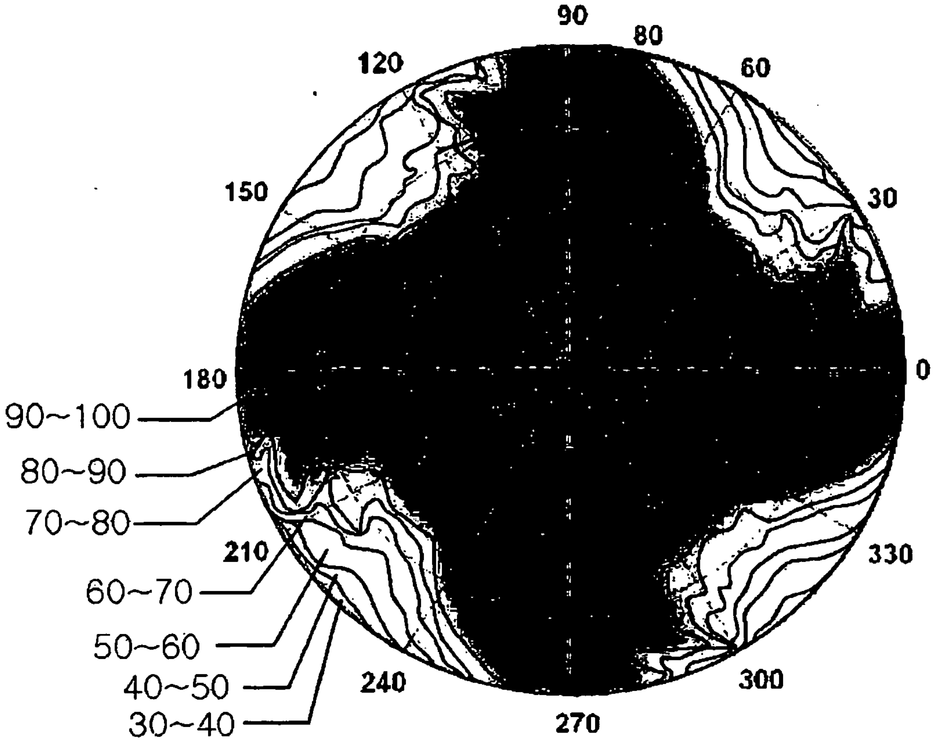
270

[Fig. 7]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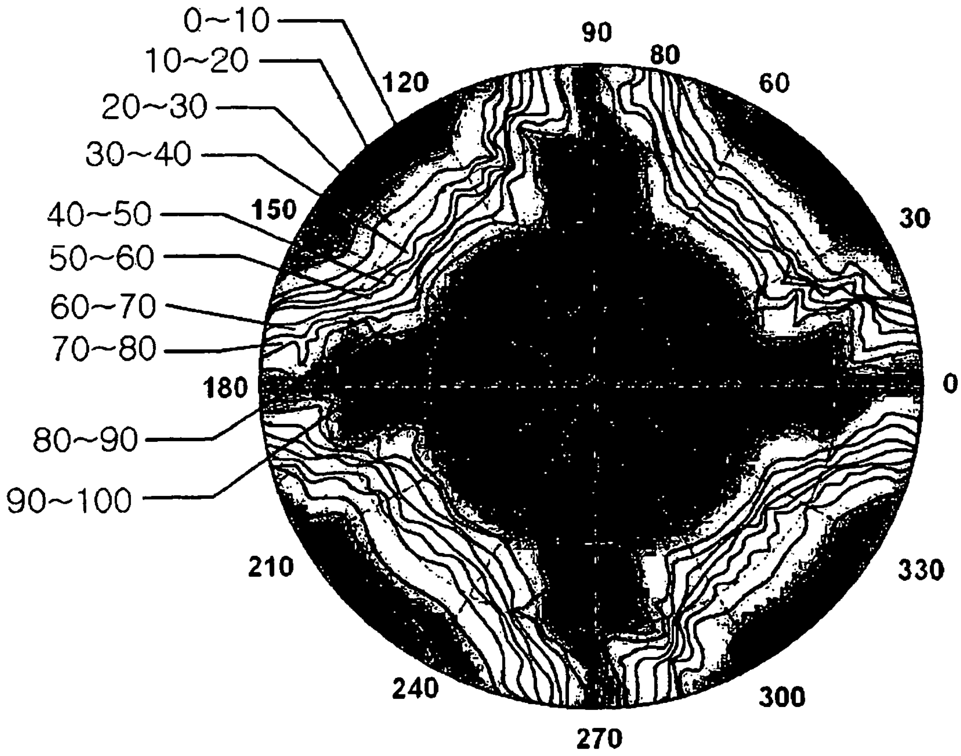
40~50
240
300
30~40
270

[Fig. 8]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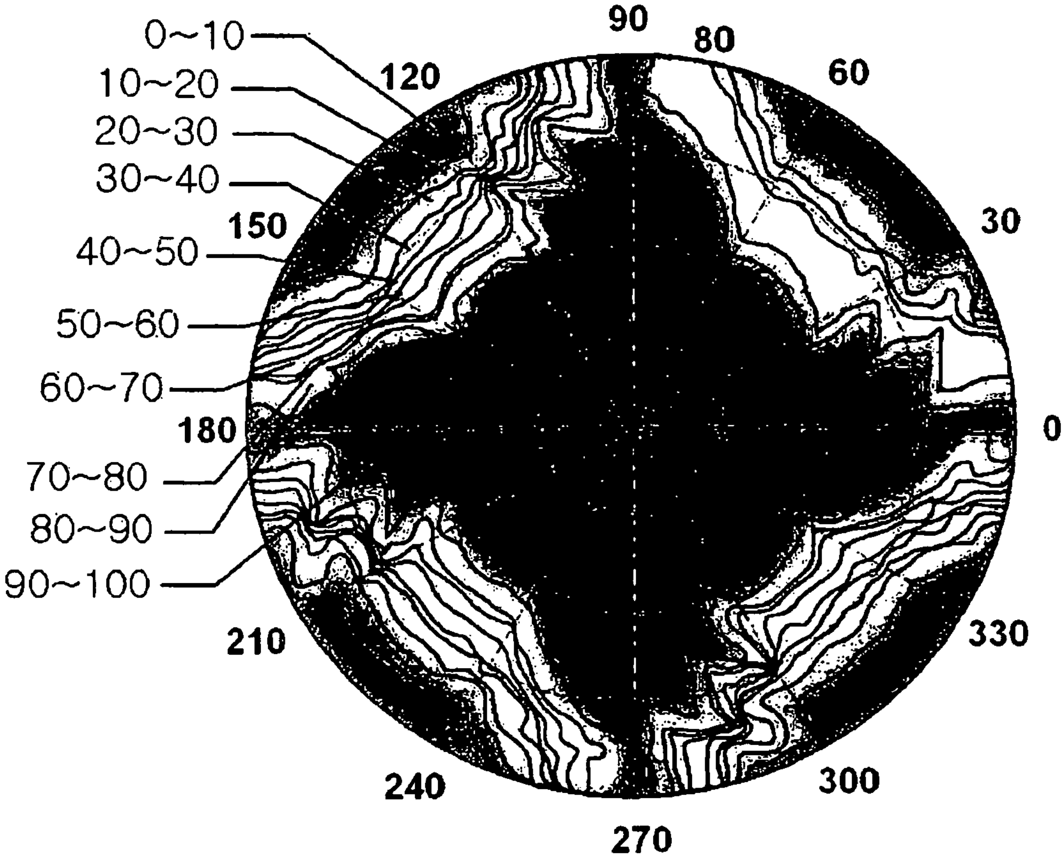
330
240
300
270

[Fig. 9]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60~70
70~80
80~90
90~100
90
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0
330
300
270
240
210
180
150
120

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	IPS模式液晶显示器使用两片双轴负延迟薄膜和一个+ c-平板		
公开(公告)号	EP1891477A4	公开(公告)日	2010-03-24
申请号	EP2006768839	申请日	2006-06-13
[标]申请(专利权)人(译)	乐金化学股份有限公司		
申请(专利权)人(译)	LG化学有限公司.		
当前申请(专利权)人(译)	LG化学有限公司.		
[标]发明人	JEON BYOUNG KUN BELYAEV SERGEY MALIMONENKO NIKOLAY CHANG JUN WON JANG SOO JIN HAN SANG CHOLL		
发明人	JEON, BYOUNG-KUN BELYAEV, SERGEY MALIMONENKO, NIKOLAY CHANG, JUN-WON JANG, SOO-JIN HAN, SANG-CHOLL		
IPC分类号	G02F1/13363		
CPC分类号	G02F1/134363 G02F1/133634		
优先权	1020050050856 2005-06-14 KR		
其他公开文献	EP1891477B1 EP1891477A1		
外部链接	Espacenet		

摘要(译)

本文公开了一种使用两片负（ - ）双轴延迟膜和一片+ C-板的IPS-LCD。 IPS-LCD在面向表面的角度和倾斜角度下具有优异的对比度，并且在黑色状态下具有视角的最小颜色变化，从而提供更宽的视角。

Inner Protective Film of First Polarizer	Retardation Values of IPS-Panel (nm)	B1-Plate		+C-Plate R_{th} (nm)	B2-Plate		Minimum Contrast Ratio at tilt angle of 75°
		R_{in} (nm)	R_{th} (nm)		R_{in} (nm)	R_{th} (nm)	
Zero Re Film (COP)	340	50	-115	310	50	-115	55.3